THE NAVIGATOR

AFRP 50-3, Volume XXIII, Number 1, Spring 1976

Your future is unlimited.....

DEPARTMENT OF THE AIR FORCE
OFFICE OF THE CHIEF OF STAFF
UNITED STATES AIR FORCE
WASHINGTON, D.C. 20330

TO THE NAVIGATOR

The Bicentennial year brings forth thoughts of all of those Americans who have contributed their skills, and many times their lives, to help keep our country free. The navigator has been an important part of this tradition. American war ships would have been a useless commodity without navigational skills to steer them accurately to each destination. Aerial navigation has come a long way from the World War I aviator who got to where he was going by following railroad tracks, to the professional today who can take his craft over vast distances with pinpoint accuracy.

We must never forget the navigator-bombardiers whose precise placement of ordnance was of major importance in defeating our enemies. Electronic warfare officers have saved countless lives by negating the enemies' use of electronically guided weapons. As time goes on, we have seen the navigator's breadth of skills increase to the point where even the leading "ace" of the Vietnam conflict was a navigator.

I would like to personally pay tribute to all of you. Your past is filled with a tradition of infinite courage and professional skill. Your future is unlimited.

William V. McBride

WILLIAM V. McBRIDE, General, USAF
Vice Chief of Staff

AMERICAN REVOLUTION BICENTENNIAL 1776-1976

FROM THE EDITOR

The theme of this issue of THE NAVIGATOR, in keeping with the Bicentennial celebration, is devoted to a historical view of aerial navigation. The Winter 1975 issue gave you an insight into 19th century navigation through the article, "Nathaniel Bowditch—The Practical Navigator." This issue will show how aerial navigation has developed from the methods used by early balloonists to a possible future use of navigation satellites. The first article, "Air Navigation—the Early Years," gives insight into aerial navigation from the 19th century up to World War II. You'll not only see the methods used, but also learn of the early pioneers in aerial navigation. World War II saw the state of the art mature from map reading to radar navigation and a more advanced use of radios. The airplane was used as a bomber, fighter, and freighter. These varied uses can be seen as the early stages of what was to come. Strategic Air Command, Tactical Air Command, and Military Airlift Command would soon come on the scene. You will see the part the navigator has played in the history of each command. Let's not forget the Reserves! The Air Force Reserve navigator has played a large role in both peace and war. You will follow him from the Korean conflict to his present role navigating some of the Air Force's most sophisticated aircraft. What about the future of navigation? Many exciting systems are being proposed, one of which is a series of navigational satellites. "Satellite Navigation—Multiplying the North Star," discusses the development of such a system. The science of navigation as well as the role of the navigator has changed tremendously over the last 200 years. What about our future—General McBride, who holds a navigator rating, sums it up in his Bicentennial message. Your future is unlimited!

Mr. Marvin C. Petersen, the author of "Silver Wings," printed on this issue's back cover, has been associated with Mather continuously since 1950. Over these many years, his ability to create superb poetry has been well recognized. "Silver Wings" is presently incorporated into every UNT graduation ceremony. Creative ability has always been noted in his leadership and guidance as general foreman of the Training Services Fabrication Branch, which is responsible for building the many trainers and mock-ups used in the UNT program. Mr. Petersen retired this January. His outstanding accomplishments over these many years of service will never be forgotten.

Editor, THE NAVIGATOR

TO THE EDITOR

Dear Editor:

"It came out of the blue and swept me off my feet," said Lt Col Quentin Charles (Q.C.) Smith, a navigator with the 79th Tactical Fighter Squadron, on hearing of his appointment as Squadron Operations Officer. It is the first time in Air Force history that a navigator has held the position in a tactical fighter squadron. Lt Col Smith feels the doors are opening for navigators and with the right experience in all branches of operations, he cannot see why they could not be appointed more often to command positions.

Ricky Ryan
Asst. Information and Press Officer
20th TFW, Upper Heyford, England

Dear Editor:

I read with interest the article by Major General Robert P. Lukeman on the history of command positions within the Air Force. The change to AFR 35-54, removing the restriction against navigators commanding flying units has probably removed the primary irritant to career minded young navigators and given impetus to the performance of some more senior types. Now that the job at the top is open to all officers, the career broadening opportunities provided by Operations Staff jobs must also be opened to all officers for normal progression to that position. This recent change has had a direct effect upon my own career. After 20 years of commissioned service as a navigator, I assumed command of the 314th Tactical Airlift Squadron (AFRES) on 2 June 1975.

John E. McEwen, Lt Col, USAFR
McClellan AFB CA 95652

Dear Editor:

Your last issue prompts this reminder that the Institute of Navigation will host an International Navigation Congress in Cambridge, Mass., 2-6 August 1976, with a theme: "TWO HUNDRED YEARS OF NAVIGATION." The technical sessions will be held in the Boston Museum of Science. We are currently soliciting U.S. items of historical navigation significance—drawings, sketches, photographs, negatives, charts, posters, etc.—of individuals, instruments, techniques, and events (no hardware) for wall or easel display in the museum. Any offering accepted will most certainly be returned. Individuals interested in participating are advised to contact either of the following for information about suggested dimensions, available display space, and shipping instructions:

Mr. John Harper
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Cambridge, Mass. 02139
(617) 258-1174

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Perhaps through your magazine the navigation community in general will be alerted to our search.

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THE NAVIGATOR

AFRP 50-3, Volume XXIII, Number 1, Spring 1976

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THE NAVIGATOR is required by regulation (AFM 5-1) to conduct a readership survey every two years. The survey is to provide trend data on distribution effectiveness, readers' awareness and acceptance, and readers' opinion as to the value and effectiveness of the periodical. Enclosed you will find a pre-addressed, postage paid, survey card. I would like to request that our readers please fill out and mail the cards. Your help in this endeavor will be greatly appreciated.

THE EDITOR

Air Navigation - *the early years*

Lieutenant Colonel William T. DEWEY
449th Flying Training Squadron
Mather AFB, California

Air Navigation as both a science and an art is a relatively new phenomenon. As a percentage of man's time on this earth the period during which he has been able to move through the air and thus require some means of monitoring and directing his progress stands as a mere quarter page in the book of recorded history. As with many other fields of endeavor, there have been periods of rapid progress, usually stimulated by the demands of either war or commerce, and periods of relative inactivity. In this article I will address, in a necessarily abbreviated form, the development of air navigation up to the beginning of World War II. At that time the Navigator as a separate rated specialist appeared on the scene to make those contributions to the mission of the Air Force and the science of air navigation which have brought the professional status we enjoy today. As few things ever spring into bloom fully grown and operational, we must look to its antecedents if we are to trace the early development of air navigation.

The ancestors of todays air navigator were the ships navigators who developed navigation from a largely hit or miss proposition into a relatively exact science. These men could plot the position of a ship from celestial observations and guide it safely to its destination. Nautical navigation is an ancient and honorable profession. When ships began to venture out of sight of land the principles of "pilotage" were no longer equal to the task at hand and a means to truly navigate was required. Early navigation was much more art than science and, at that, an art that developed slowly over the centuries. Even when many celestial principles were known the lack of an accurate means of measuring time during long periods at sea reduced their usefulness. Progress in the development of a reliable chronometer had by the early part of the 19th century solved much of this problem. The work of such distinguished American sailors as Nathaniel Bowditch and Thomas Sumner, during this same period, resulted in ships navigators being able to accurately determine their position through celestial means. With this knowledge they were able to sail for weeks at a time out of sight of land and yet effect a reasonably accurate landfall at voyages end. When man began to sail on the oceans of the air it was only logical that his attempts at navigation began by borrowing the methods and often the equipment of his waterbound compatriot.

The first air navigators were the balloonists of the 19th century. These pioneers experimented with many of the techniques that would later be considered standard procedures on the aircraft of the following century. Monte D. Wright in his definitive work "Most Probable Position" (Univ. Press of Kansas, 1972), detailed many of the accomplishments of the early flyers and much of the equipment development which I will discuss in this

Early aviators used visual means of navigation.

article. The aneroid barometer and the technique of groundspeed by timing were both products of these early navigation efforts in lighter than air craft. The most far-reaching of these early contributions, however, was the development of the bubble sextant.

The balloonists discovered very early that the standard marine sextant was useless at any significant distance above the ground as the natural horizon was no longer available as an accurate reference from which to measure the height of the body. Various methods of producing an artificial horizon were tried but all proved less than satisfactory. Eventually, the principle of the carpenters level was applied to the problem and in 1901, the first bubble sextant appeared. It was then possible to take accurate celestial sightings regardless of altitude above the surface. As accurate, anyway, as could be expected in a bobbing and weaving basket suspended from a balloon. The balloonist could by the beginning of this century solve the first part of the navigators basic problem, where am I. As his craft moved at the mercy of the winds, however, there was little he could do about the second part, directing his ship of the air to a predetermined destination. This change from a passive to an active role had to await the arrival of the powered air machine, a craft with sufficient capabilities of speed and range to require his services.

The navigation of the early airplanes, in the period prior to World War I, was accomplished either by the pilot or by a second individual acting as observer. The method used was in almost all cases pilotage. That is, they flew from landmark to landmark or else in a general direction until they recognized some object and then corrected their heading.

Instruments to aid in navigation were practically unknown. Bleriot, when he made the first aerial crossing of the English Channel in 1909, didn't even have a compass on board. The limited speed and endurance of these early aircraft made this type of basic navigation acceptable. With the advent of the First World War and the resulting rapid acceleration of aircraft capabilities, more advanced navigational techniques and equipment were needed. Unfortunately, navigational developments failed to keep pace with the improvement in aircraft.

Throughout World War I, map reading was the primary aid to navigation. Air activity was largely restricted to periods of good weather and during those times map reading was an effective technique. It was also one that could be taught fairly quickly to inexperienced pilots. There was some use of dead reckoning, and early driftmeters were used to measure drift and to compute groundspeed by timing. The "double drift" technique was also developed during the war. The first known hand held DR computers appeared during that conflict as did the first effective bombsights. These were basically driftmeters with a sighting telescope attached. Probably the most significant advancement in the field of navigation during this period was the use of radio as a navigational aid. As the quality of radio equipment available for aircraft use improved the technique of taking bearings off ground stations came into more widespread use. German Zeppelins, which could carry larger and therefore more efficient radio gear, used it as their primary aid whenever the weather precluded taking map reading fixes. The crews bombing England, however, were hampered by the location of the ground stations which resulted in poor cuts and often very poor results. The bomber crews of both sides used map reading as their normal means of navigation although some aircraft were equipped with radio and utilized it as a navigational aid. Although the desirability of having one crew member able to devote his full attention to navigation was soon evident this task continued to be the responsibility of either the pilot or a designated aerial observer with little or no navigation training. The emergence of the trained military navigator as a separate specialty would have to await the passage of more than twenty years and the impetus of yet another World War. The inter-war period, however, saw considerable experimentation and significant, if limited, progress in the field of air navigation.

The immediate post war years of the 1920 s was not a time conducive to great strides in any segment of military aviation. The budgets were small and the mood of the country placed little emphasis on military preparedness.

Early vintage Condor bomber.

There were a few farsighted visionaries, however, who continued to work to improve the capabilities of air navigation whenever the opportunity arose. I am indebted to Major General Norris B. Harbold, USAF (Ret) through his book "The Log of Air Navigation" for much valuable information concerning navigation training in the Army Air Corps during this period. Extensive experiments were conducted at Langley Field in 1918 and 1919. It was proven that by using a bubble sextant and averaging readings acceptable airborne work could be done. The intercept method of plotting and the use of pre-computation of celestial information was an important part of that project. Although the post war period saw military aviation placed on the back burner, if not completely off the stove, the war had aroused a great deal of general interest in aviation and its possible application to peacetime commercial ventures. A number of long range flights were undertaken to demonstrate the fledgling industries potential as a commercial carrier. Navigation was a necessary part of these long range, often overwater, flights. Alcock and Brown, the two Englishmen who in 1919 made the first nonstop flight across the Atlantic, used both day and night celestial with good results. By the 1930 s, navigators were an important part of many record-breaking crews. Harold Gatty, the famous Australian navigator, later employed by the Army Air Corps as an advisor on navigational matters, served as Wiley Post's navigator on his early around the world flight. Lt (later Colonel) Thomas Thurlow, one of the Air Corps first navigation instructors, served as Howard Hughes navigator on his famous globe circling flight of the early 30 s. Fred Noonan, an experienced navigator with Pan American, flew with Amelia Earhardt on her last record breaking attempt. The Air Corps too took part in these early long range flights. Lt Albert F. Hegenberger had served as an early navigation instructor at McCook Field in 1919 and was one of four Air Corps officers who received a short course in air navigation from the Navy at Pensacola in 1920. In 1927, he and Lt Lester J. Maitland made the first non-stop flight from California to Hawaii. Celestial was their primary navigational aid. Ten years later the famous Clippers of Pan American were providing regularly scheduled service across the wide expanses of the Pacific. As these early pioneers, among many others, developed the skills and techniques that are a necessary part of successful navigation in the airborne environment; progress was also being made in the equipment with which they practiced their profession.

Many of the instruments and much of the equipment which we take for granted today were developed in the period between the wars. The Astro-Compass (yes Virginia there was such a device) was developed in 1920 and used well into the 1960 s.

Lt. A. F. Hegenberger discusses sextant usage with compatriot.

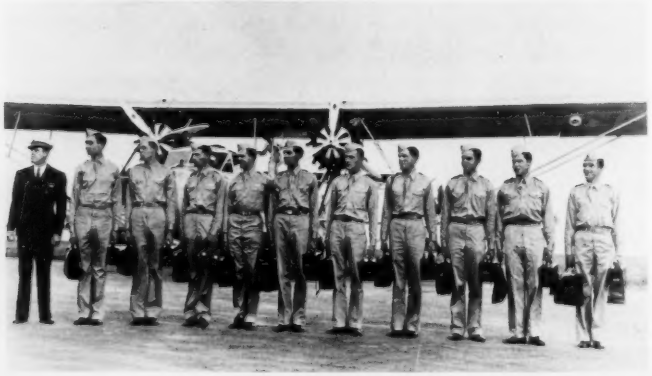
The Directional Gyro appeared as a result of work by Sperry Rand in the '30 s and is still widely used today. The gyro-stabilized driftmeter was also first produced in this period as was the absolute (radio) altimeter. The radio compass came into general use in the middle '30 s and was adopted by the Army Air Corps in 1935. The first sextants to incorporate an averaging device were also developed, after many problems, in the latter part of the decade. The inter-war period also saw slow but significant progress in the area of aerial charts and maps, celestial tables, and manuals.

Obtaining the proper maps and charts for air navigation has been a problem for flyers since the days of the early balloonists. Road and railroad maps were the first ones used. These maps did not show the distinctive topographic features necessary for good map reading and lacked the latitude and longitude scales needed for more advanced techniques. Naval charts could be used for overwater work but these did not cover inland areas. Various military topographic maps were used but even these did not show either terrain or cultural features as they appeared to the aviator. The first successful aerial maps produced in this country were a commercial venture by the Rand McNally Company. Their "Air Trails Maps," first appeared in 1928 and were widely used by the Air Corps. The familiar government produced Sectionals were begun in 1931 with the first series being completed by 1936. There were, however, major portions of the earth that were still not charted at all by the end of the decade. The navigators on the first long range flight of B-17 s to South America in 1938 had to obtain maps from the National Geographic Society. As the maps and charts slowly developed so did the necessary celestial tables and navigational manuals. The Air Almanac was first produced by the Naval Hydrographic Office as an experimental publication in 1933. It did not become a regular item until 1940. The H.O. 214 celestial tables were first published in 1936 and replaced several different tables previously in use. The 214 s were the standard throughout World War II and

were the immediate predecessors of the H.O. 249 s we use today. Comprehensive manuals also began appearing in the early 1930 s. Weems' book "Air Navigation" was published in 1931 as was a text for the Army Air Corps Flying Training School by Lt Harvey H. Holland. The first Air Corps text on "Celestial Air Navigation" was written by Lt Thurlow and first issued at March Field in 1934. It was later published at Randolph Field in 1937.

Formal training schools for air navigation also appeared during that time frame as the demand increased for trained navigators both military and civilian. The best known civilian school was the Pan American program at Coral Gables, Florida. The Army Air Corps approach to formal navigation training between the wars was limited both by budget constraints and by the perception of the mission. There was little money available to pay for "nice to have" items such as a formal navigation school. Also, as the mission was to defend the continental U.S., there was little perceived need for that type of training on the part of many senior officials both in and out of uniform. Fortunately there were some officers with vision who saw the importance of having aircrews trained in navigation. As a result of their efforts to move beyond the "pilotage" level, some training was conducted. A navigation familiarization course was taught to those pilots attending the Air Corps Tactical School (forerunner of the present Squadron Officers School) beginning with classes in 1928. Beginning in 1931 some short courses were taught in various Air Corps units. In 1933 and 1934, navigation training was conducted at Langley Field for east coast personnel and at Rockwell Field near San Diego for those stationed on the west coast. This was the most ambitious effort to date but it had to be discontinued when the Air Corps was directed to launch a major effort in carrying the air mail beginning in February 1934.

One of the graduates of the Langley course was a man who was to make a major contribution to air navigation both as a navigator and combat leader. This aviator was (then lieutenant) Curtis E. Lemay. After the air mail episode and a return to normal status, navigation training reverted to the individual units. The unit instructors were, when available, graduates of either the Langley or Rockwell Field programs. Lieutenant Lemay and a fellow graduate taught a ninety day course including celestial at Wheeler Field in Hawaii in 1934 and 1935. With the arrival of the more modern B-10 s, B-17 s and B-18 s in the middle and late '30 s, the crew concept came into vogue. The need for specialized aircrew members became even more evident. The initial solution was to train pilots as navigators and bombardiers. This concept met with less than total enthusiasm from the pilots detailed to serve in those capacities. It also resulted in time consuming and costly additional training. As a result of the problems encountered, the Chief of the Air Service Plans Section recommended that navigators, as separate rated specialists, be trained and commissioned. His suggestion was turned down. In the meantime, several significant navigation events occured in the last half of the decade.



Student navigators at the Pan American navigation school.

Gardner-Crocker direct sighting azimuth reading, no bubble, aircraft sextant, 1936.

Pan American began regularly scheduled trans-Pacific service with their classic China Clippers in 1935. In 1939 they expanded their operations to include the Atlantic. Their aircrews included navigators who were trained in Pan American's own school. Celestial was their primary aid as they crossed the vast expanses of both oceans. The routes they pioneered would in many cases be followed by thousands of bombers and transport aircraft in a few short years when the Second World War burst upon the scene. Anxious to demonstrate the capabilities of their new bomber aircraft and the ability of their crews to find targets located at great distances from their home fields, the Army Air Corps made a number of well publicized flights.

The flight of the B-10 s to Alaska in 1934 led by Lt Colonel Hap Arnold is well known today. Less well remembered perhaps are the three flights made to South America by B-17 s in 1938 and 1939. One of the pilots designated as crew navigator on the first of these flights

(to Buenos Aires) in February 1938, was Lt Curtis E. Lemay. He also served as navigator on the flight to Bogata, Columbia in August 1938 and to Rio de Janeiro in December 1939. These flights were significant not only because of the distances flown but because of the confidence generated in the navigational proficiency of the aircrews. To demonstrate the ability of the B-17 s to seek out and destroy naval targets, the Air Corps planned a highly publicized mission to intercept the Italian Liner "Rex" several hundred miles out to sea as part of the 1938 war games. The lead navigator on this successful mission, encountering extremely adverse weather conditions, was once again the redoubtable Lt Lemay. Any old SAC types have only to read the account of General Lemay's experiences on this and other missions of the period to understand his empathy and appreciation for navigators during his time as CINCSAC and later Chief of Staff. I highly recommend his autobiography, "Mission With Lemay" (Doubleday & Company Inc., 1965) to you. The impetus of the war in Europe and the possibility of U.S. entry caused a rapid expansion of the Air Corps beginning in 1940. The desirability of having a trained specialist in navigation and/or bombing was at last given official recognition and training was begun.

The first training to be started was for bombardiers. The initial class of aviation cadets began training at Lowry Field, near Denver, in July of 1940. Due to a shortage of qualified navigation instructors in the Air Corps a contract was let to Pan American who began training cadets as navigators at their Coral Gables School in August of 1940. The first class graduated in November. A number of this class were assigned as instructors to the first Air Corps' navigation school at Barksdale Field in Louisiana. One of these was Norman P. Hays for whom the Institute of Navigation's prestigious award is named. Others went to operational assignments and some members of this first class flew with General Doolittle on the Tokyo raid. It is interesting to note that although the first class graduated in November of 1940, their commissions were delayed until July of 1941. Until that time they served as "Graduated Cadets." By December of 1941 there were navigation schools at Kelly, Mather, and Turner Fields.

Navigator position, B-17F.

Certificate of Proficiency
Aerial Navigation

This is to certify that Captain Elmer P.Rose, Air Corps,
has qualified as a Celestial Navigator in the
General Headquarters Air Force

By command of Major General Andrews:

WILLIAM W. DICK,
Major, A. G. D.,
Adjutant General.

22 July, 1938.

By the time of our entry into World War II the Army Air Corps navigator was ready. Ready to serve with distinction in combat in every theater of operations and to begin the tradition of service and professionalism which has been passed on to those of us who proudly wear the silver wings today. It was a long road from the early balloonist to the bright young second lieutenant ready to climb aboard his B-17 or B-24 and carry the air war to the enemy. We owe a great deal to the early pioneers, particularly those of the 1920 s and 30 s. Their work made the rapid expansion of 1940 and 1941 possible. Some such as Major General Harbold, Major General A.F. Hegenberger (the Hawaii flight navigator) and General Curtis E. Lemay went on to distinguished Air Force careers. Others of this select group gave their lives in aviation. Colonel Thomas Thurlow was killed in an air crash in 1944 as was Harold Gatty who died at Fiji in 1957.

Regardless of their eventual destinies, their contribution to the development of air navigation and to the professional status of the navigator has assured them of an honored place in the history of this scientific art.

Lt Col William T. DEWEY

Lt Col (Colonel selectee) William T. Dewey entered the Air Force via ROTC upon graduation from Utah State University in 1959. After completing UNT and NBT, he was assigned to the Strategic Air Command as a B-52 navigator. After several years of service as both a navigator and radar navigator, Lt Col Dewey left SAC in 1966 for a tour in SEA in the C-123. Following that assignment, he served for three years in Germany in the RF-4C where he was Wing Navigator and Chief Nav Flight Examiner. Lt Col Dewey also served a tour of duty with Air University prior to his present assignment as Commander of the 449th Flying Training Squadron at Mather.

TAC NAVIGATORS: MEETING

Major Ronald E. SCHULZ
Air Command and Staff College
Maxwell AFB, Alabama

Navigators have been in the Tactical Air Command (TAC) since 1946. During the early years navigators flew in transports, light bombers, and tankers. The navigator in TAC can be justifiably proud of his accomplishments and versatility. He has flown in over 22 different types and models of aircraft in the past 15 years, sometimes as a navigator, but more often as weapon systems officer or electronic warfare officer—roles that came to navigators only recently.

The big thrust for greater utilization of the TAC navigator began in the early 1960s with the formation of the 1st Air Commando Group. The arrival of commando aircraft greatly expanded the utilization of navigators in TAC. Next came the birth of the Wild Weasel mission and the initial role of the navigator in tactical fighter aircraft. Shortly thereafter, the pilot shortage led to the replacing of rear seat pilots in the F-4 and RF-4 and right seat pilots in the F-111 with navigators. TAC airlift navigators during this time were meeting many unique requirements in such places as Vietnam, the Congo, the Dominican Republic, and Korea.

The first commando-type Air Force unit following World War II was formed at Hurlburt Field, Florida, in April 1961. Nicknamed "Jungle Jim," it was the Air Force's counterpart to the Army's Special Forces and its mission was special air warfare. Within five months the unit achieved operational readiness. Aircraft assigned to the commando unit utilizing navigators were the B-26 and the C-47. One of the unit's first deployments was a Mobile Training Team (MTT) to Mali. Shortly thereafter, another detachment of Commandos deployed TDY to Vietnam to begin training South Vietnamese in a variety of missions—strike, resupply, paratroop drops, defoliation, and psychological warfare.

Navigators were aboard C-47 Skytrain aircraft used for psychological warfare, and close support missions.

The A-26 Invader "packed quite a punch" with its nose mounted machine guns and substantial external ordnance.

In April 1962, the 1st Air Commando Group was reactivated. Additional aircraft utilizing navigators were added, including the C-46 and the C-123. The training that navigators received in special air warfare was rigorous and highly specialized. While all Air Commandos were trained in the latest methods of counterinsurgency, their aircraft were vintage models that collectively resembled a flying circus. Moments of apprehension were never in short supply for the navigator flying these unsophisticated aircraft across both ponds and over pitch black landscapes in unheard of places. Imagine flying a two-engine recip across the vast expanse of the Atlantic or Pacific ocean at 140 miles per hour with navigational aids like the

THE CHALLENGE

old Astrocompass, the MA-2 hand-held sextant, the APN-9 Loran and the Army Air Force pencil-type driftmeter.

The jet assisted C-123K Provider had faster climbout capabilities which helped it avoid enemy small-arms fire.

Wherever they went, the Commando navigators distinguished themselves despite their antiquated machines and equipment. A graphic example occurred on 20 July 1963. Flying a SC-47 out of Bien Hoa on a night flare mission, an Air Commando crew was diverted to rescue six critically wounded ARVN soldiers at Loc Ninh. The weather was bad and the airstrip was nestled in a valley between mountains 500 feet high. Navigational aids and lights were non-existent. Since the field was only eight miles from the Cambodian border, a slight navigational error could have meant missing the strip or even triggering an international incident by violating the border. The only landing aids available were makeshift gasoline-soaked toilet paper rolls jammed on sticks and set afire on each side of the runway. Despite difficult flying conditions, the wounded Vietnamese were taken out successfully. For their effort, the crew won the 1963 MacKay Trophy for the most meritorious flight of the year. The navigator on that crew was Captain Donald R. Mack.

Navigator duties in the B-26 and the later modified version (A-26) were quite different from the normal navigator duties (with the exception of map reading and dead reckoning). The B-26/A-26 navigator was the forerunner of the modern day weapon systems officer (WSO). He was jokingly called a "Piligator" by his pilot. The piligator's duties as a right seater involved close coordination with the pilot in

A-26 "Piligator" receives pre-mission briefing.

accomplishing checklist items, monitoring engine instruments, making radio calls, managing the fuel, and arming various weapon systems. Most pilots who flew these aircraft made it a personal point to teach their piligators to fly and land the aircraft. It was their ticket back home alive. This practice paid dramatic dividends on Friday the 13th of January 1967. While on a night armed reconnaissance mission in Southeast Asia, an A-26 was hit by ZPU in the nose section on the pilot's side while flying at an altitude of 200 feet. The pilot slumped against the yoke. The piligator, Captain Fred T. Moomau, immediately took control of the aircraft and gained altitude. The cockpit had rapidly filled with smoke, the armament panel had been knocked off and one of the pilot's rudder pedals was all but gone. The aircraft commander was not unconscious, but he had been seriously wounded and had grabbed for his injured legs. The crew analyzed the situation and began their return to base. Once in the area of the home field, the crew experienced difficulty getting the gear down and the left engine began to backfire. They had to get the aircraft on the ground in a hurry. Captain Moomau assisted the pilot in flying the battle damaged aircraft and operating the rudder pedals. After landing, he applied the brakes and helped his injured pilot from the aircraft. It amply demonstrated the payoff in teaching the navigator to fly and land the aircraft as necessary. As the tempo of war in Vietnam increased, the number of Air Commandos grew and more types of aircraft utilizing navigator talents were added.

Another milestone opportunity for the TAC navigators began in July 1965, with the birth of the Wild Weasel mission. This would be the first time that navigators were to be used in tactical fighter aircraft. Prior to this time, electronic warfare (EW) had been defensive in nature. The Wild Weasel would be the first offensive EW program and the electronic warfare officer (EWO) would be the back seater in the F-105 aircraft. The primary objective was to counter the growing North Vietnamese surface-to-air missile (SAM) defense by seeking the SAMs out and destroying them. Navigators selected for the back seat of the F-105 Thunderchief were for the most part, electronic warfare officers with prior experience in the B-52. The EWO quickly became accustomed to high "G" force maneuvers and high speed, low level missions. Teamwork was essential. The most important duty of the EWO was to keep his pilot informed of the tactical electronic situation; this knowledge allowed the pilot to determine whether an attack should be made and what tactics to use. What made the mission unique was that everything had to be accomplished between the crew in a matter of seconds. If the Wild Weasels were successful, the strike forces coming into the area could deliver their ordnance without having to evade SAMs and anti-aircraft fire. The Weasels were the first in the target area with the strike force and the last ones out. When the F-105 finally retires to the boneyard, the navigators who flew the Wild Weasel will know that they have an essential part in the history of the aircraft.

F-105 Wild Weasel navigators were an invaluable member of the team which helped destroy innumerable SAM sites.

When the Air Force decided to acquire the F-4, RF-4, and RF-4C in the early 1960s, the TAC navigator unknowingly took another giant step forward. Initially, the crews of the two-seat F-4 and RF-4s were composed of pilots. To orient the TAC fighter crews in the use of the highly sophisticated search, track, and missile launch radar of the F-4, 12 navigator/radar intercept officers at James Connally AFB, Texas, were assigned to the 4453rd Combat Crew Training Wing at MacDill AFB, Florida. They were to develop the lead-in course for pilots who would fly the rear seat of the F-4. Although navigators had to wait six years before they began to replace pilots in the rear seat, these 12 NAV/ROs were the first "Fighter-gators" in TAC.

F-4 on combat mission in Vietnam.

By mid-1967, the Air Force was short of pilots. Although pilot production was increased, it was apparent that a shortage would continue through the early 1970s. At the Defense Department's request, the Air Force initiated the "Combat Team" project to study the feasibility of replacing rear seat pilot crew members in the F-4 aircraft with navigators. Their report concluded that either a pilot or navigator could perform rear seat duties and the proficiency differences could be resolved through modified crew training programs. In July 1968, it was officially decided to begin replacing pilots with navigators in the rear seat of the F-4 and RF-4 and the right seat of the F-111. The navigator in TAC was now afforded another opportunity to show his mettle.

Navigators selected to become weapon systems officers received six months training at either a Combat Crew Training School (CCTS) or a Replacement Training Unit (RTU). At these schools, the navigator received academic, simulator, and flying training related to the specific aircraft he would fly. Upon graduation, the F-4 navigator maintained proficiency in air superiority and weapons delivery. In the RF-4C, he maintained proficiency in the tactics used in aerial photography to locate the enemy and monitor his movements. In the F-111, he maintained proficiency in the more specialized role of precision low level interdiction bombing. TAC is responsible for WSO training not only for their own command but also for ADC, PACAF, and USAFE. Instructor WSOs are key members of this training program.

Navigation plays a minor role in the duties of the WSO. The WSO is much more involved in the many tasks associated with the operation of the weapon systems. His crew duties include those of a radio operator, a radar air-to-air intercept operator, a radar air-to-ground armament delivery operator, a multi-sensor systems operator, an electronic warfare officer and, of course, a Magellan. He is expected to either have eyes in the back of his head or a head that revolves 360 degrees. During the non-critical phases of flight, he is given the opportunity to fly the aircraft and many WSOs have become quite proficient at piloting. Many have gone on to flight school and are now aircraft commanders in the F-4, RF-4, and F-111. Not unlike the B-26/A-26 navigators, some WSOs were able to bring the aircraft back from combat missions

F-111 right seater directs his craft with advanced avionics systems.

Precision airdropping, by C-130 navigators, of vitally needed food and munitions helped supply our troops throughout the Vietnam conflict.

when their ACs were injured. Many untold feats of heroism were performed by the WSO in SEA and elsewhere. The navigators have become part of the "fast movers" jet force, have become ACEs (Captain DeBellevue and Feinstein), and definitely found their niche in tactical fighter operations.

The airlift navigator has made innumerable contributions over the past 15 years. Most TAC navigators during the early 1960s performed in airlift and covered an area encompassing the entire free world. Some of TAC's C-130s on USAFE rotation flew to Moscow. You could find them navigating C-130 resupply missions to such exotic places as the DEW line of North America, the Greenland glacier, and the Antarctic ice cap. Many TAC navigators flew in C-123 and C-130 aircraft carrying men and equipment for the US Army. Air dropping and assault landing, their motto was "Anywhere, Anytime!" The navigator's expertise was exemplified during the Congo rebellion of 1964. As crew members of the 464th Troop Carrier Wing, navigators played a key role in the successful airdrop and air-landing of a fully equipped battallion of Belgian paratroops in the heart of rebel-held territory. This action initiated the humanitarian effort of evacuating more than 1500 hostages and refugees from Stanleyville. For their efforts, the 464th Troop Carrier Wing at Pope AFB, North Carolina, won the 1964 MacKay Trophy. The following year airlift navigators were doing their part in transporting the 82nd Airborne Division to the Dominican Republic. On the other side of the globe, TAC airlift navigators were resupplying, trash hauling, and air evacuating American forces at Phu Cat, Khe Sanh, and many other bases in Southeast Asia.

More recently, navigators have flown on humanitarian flights to earthquake stricken areas in Alaska, Peru, Nicaragua, and Turkey delivering relief supplies. Thousands of tons of grain were hauled to starving Africans in Mali, Chad, and Mauritania. Additionally, troops and equipment have been dropped in practically every free world country during exercises or actual contingencies. It is quite apparent that the airlift navigator performed his duties well. His transfer to the Military Airlift Command (MAC) is TAC's loss.

While airlift forces were transferred to MAC, TAC retained C-130 navigators for specialized mission roles in the Combat Talon, Gunship, and Drone Launch aircraft. For the most part, the tools of the past—the plotter and divider—are not applicable to the tactical fighter and reconnaissance navigator. In their place are the Inertial Navigation System, Digital Computer Complex, and Fire Control System to name but a few.

What does the future look like for the navigator in TAC? The F-4, RF-4, and F-111 will be part of tactical weaponry for quite some time. Acquisition of the F-15, F-16, and A-10, however, does not portray a rosy picture.

The TAC navigator is a talented professional and will not stagnate. He has proven his ability to master new techniques and concepts and this can only lead to greater challenges. Hopefully, the systems of the future will demand the talents of the WSO. If so, the TAC navigator will meet the new challenges as he has done in the past—with vigor, enthusiasm, and professionalism.

Major Ronald E. SCHULZ

Major Ronald E. Schulz is a graduate of the University of Evansville. Following navigation training in 1964, he was stationed at Hurlburt Field, Florida, flying C-123s. Next, Major Schulz spent four years in C-46s, C-47s, and C-118s on assignment throughout Central and South America before moving to Homestead AFB as an instructor with the 308th Tactical Fighter Squadron. In 1973, he began rated supplement duty in the Personnel Branch at TAC Headquarters, and he is currently enrolled at Air Command and Staff College.

history of MAC

Office of MAC History
Headquarters Military Airlift Command
Scott AFB, Illinois

THE EARLY YEARS

MAC's earliest roots are to be found in the Air Service Command's transportation squadrons and the Air Corps Ferrying Command (ACFC). The latter was established in May 1941 to ferry aircraft to the eastern seaboard and to transport essential personnel and mail to the United Kingdom. Later the ACFC mission was expanded to include the delivery of aircraft, personnel, and critical supplies to American and Allied bases worldwide.

When the United States entered WWII, it was obvious that the existing air transport systems were inadequate, so various proposals, including militarization of the domestic airlines, were tried. By mid-1942, however, it became apparent that the solution to the transport dilemma was to consolidate the various Army transport endeavors. Accordingly, on 20 June 1942, the Air Transport Command (ATC) was formed and assigned the global ferrying and War Department air transportation (except troop carrier) missions, operating and controlling all of the air routes outside the United States that were assigned to the Army Air Forces.

The ATC compiled an enviable war record and was instrumental in keeping open the critical logistics pipelines and in developing aeromedical evacuation techniques.

When the war ended, ATC, along with its Naval counterpart, the Naval Air Transport Service (NATS), had shown the feasibility and need for air transport units.

FORMATION OF MATS

After the war Secretary of Defense James Forrestal directed a 1 June 1948 consolidation of the Air Force and Navy air transport services. The resulting Department of Defense agency, the Military Air Transport Service (MATS), received all the ATC assets and personnel and about half of those belonging to NATS, bringing to the newly established U.S. Air Force another major command.

MATS was organized into three airlift divisions, including the Naval units (whose distinct identities were maintained). Also assigned to the new command were the former ATC technical services: Air Weather Service, Airways and Air Communications Service, and the Air Rescue Service.

BERLIN AIRLIFT

In June of 1948 a massive aerial supply operation was set in motion to counteract the Russian's cold war blockade of the land corridor into West Berlin. This action, known as the Berlin Airlift, soon drained away the MATS C-54 and the Navy R5D aircraft and personnel to USAFE (United States Air Forces, Europe). Navigation through the corridor by these personnel required great precision. Straying out of the corridor could have resulted in a confrontation with the Soviets. Major General William H. Tunner, the MATS Deputy Commander, was selected to command the Combined Airlift Task Force (CALTF) which included British, French, and American elements. By the end of July 1949, CALTF had delivered 2,231,600 tons of fuel and food in 266,644 trips into Berlin from West Germany.

KOREA

On 25 June 1950 the North Korean Army attacked South Korea. The United States, backing the United Nations, opposed the aggression. The Air Force immediately established two airlifts, the one transpacific to Japan, the other intratheater between Japan and Korea. The transpacific airlift, set up under MATS, included some 60 U.S. civil air carriers, the Pacific Division of MATS, a squadron of Royal Canadian Air Force aircraft, elements of Canadian Pacific Airlines,

and a flight of Belgian aircraft. The intratheater airlift received some MATS units with General Tunner commanding. Again, MATS navigators were called upon to get the job done.

MATS also supplied aeromedical evacuation of the wounded and sick from the combat theater. Air Rescue Service aircraft were sometimes the first link in this chain, recovering wounded personnel, often from behind enemy lines, and carrying them to hospitals behind the front. From there the wounded were flown to hospitals in Japan by theater aircraft, and from Japan over 66,000 personnel were evacuated to the U.S. on MATS air transports. These procedures, developed in the 1950-1953 era, were brought to an even fuller application during the SEA conflict.

REORGANIZATION AND MODERNIZATION

In 1956 the Department of Defense, in the interest of economy and efficiency, put long-range air transportation under single managership, naming the Secretary of the Air Force as the single manager and MATS as the implementing agency. DOD further prescribed that, beginning in FY 1959, the users of airlift would budget and pay for it under an industrial fund operation.

After 1955, the U.S. civil airlines became increasingly active in contracting for government traffic, particularly passenger service. Many airlines complained that MATS competed with them. Congressional hearings echoed these complaints, and newspapers and airline associations joined in criticizing MATS.

While this debate was going on, MATS again demonstrated its reason for existence when, in 1958, the President of Lebanon asked the United States for protection, fearing overthrow of his government. MATS was directed to dispatch C-124 aircraft to assist in airlifting theater forces to Beirut. At the same time that this airlift was in progress, MATS was also called on to assist in the deployment of Air Force units to Taiwan, which was threatened by the Chinese communists.

Although successful, these operations pointed up the need for more modern airlift systems. To demonstrate this point a test exercise, BIG SLAM/PUERTO PINE, was conducted in March 1960. Involving the airlift of about 21,000 troops and some 11,000 tons of equipment to staging areas in Puerto Rico and then flying them back to "Employment" areas in the CONUS, BIG SLAM/PUERTO PINE focused public and Congressional attention on the need for modernization. As a result, funds were made available in the spring of 1960 to re-equip MATS with off-the-shelf C-135 and extended range C-130E aircraft, and to develop modern long-range jetcargo aircraft. The implementing public law and appropriation stipulated that none of the aircraft would be used for regular passenger service. Thus, MATS began its aircraft modernization program and quieted the critics.

After World War II, it became apparent that there was a continuing need for civil augmentation airlift to support DOD requirements in emergencies. The Civil Reserve Air Fleet (CRAF) program was created by Executive Order in 1951 and implemented by DOD/Department of Commerce memorandum which outlined guidance for its use in emergencies. Notably absent from the program was any provision for calling into federal service parts of the CRAF for exigencies short of war. This problem was resolved in 1963 by modifying the contracting procedures to provide for incremental call up of CRAF elements.

The Cuban crisis brought MATS airlift into action immediately, for many of the resources required for armed intervention had to be quickly assembled at staging bases. Marine forces were airlifted both to Guantanamo, Cuba, and to CONUS stations within easy striking distance of Cuba. Military airlift thus displaced was replaced by commercial airlift, so that logistic support could continue during the contingency.

REDESIGNATION OF MATS TO MAC

MAC's wartime mission, which included the airlift of troops and equipment within combat areas, was one of the reasons Military Airlift Command (MAC) was deemed a more appropriate name than Military Air Transport Service (MATS). Congress agreed, and redesignation was effective 1 January 1966. Other redesignations changed EASTAF to 21st Air Force, WESTAF to 22nd Air Force, Air Rescue Service (ARS) to Aerospace Rescue and Recovery Service (ARRS), and Air Photographic and Charting Service (APCS) to Aerospace Audio-Visual Service (AAVS). In October 1965, cartographic and geodetic services had been withdrawn from APCS and transferred to the 1370th Photo Mapping Wing, which became one of MAC's four specialized wings. Three years later the 1370th was redesignated a technical service, Aerospace Cartographic and Geodetic Service (ACGS).

SEA

The buildup of U.S. Armed Forces in SEA, which began in late 1965, resulted in a tremendous increase in airlift requirements for troops, patients, cargo, and mail. Requirements far exceeded MAC airlift capability. Air Force Reserve and Air National Guard units plus purchased airlift from U.S. civil carriers were used to complement MAC's airlift forces.

C-141 operations into SEA were inaugurated on 5 August 1965. Their productivity was ably demonstrated in 1966 with Operation BLUE LIGHT, the airlift of 3,000 troops and nearly 5,000 tons of equipment from Hawaii to Pleiku, Vietnam, in only 17 days.

In November 1967, MAC began EAGLE THRUST, the largest and longest military airlift ever attempted into a combat zone. C-141s and C-133s airlifted 10,024 troops and 5,357 tons of equipment of the 101st Airborne Division from Ft. Campbell, Kentucky, to

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Lt Col James Warren (Left), the navigator on the first Homecoming mission, greets returnee Col Fred Cherry, USAF.

Bien Hoa, Vietnam. MAC would continue to use their massive airlift capabilities throughout the war. With the end of the war came the return of POWs.

One of the most dramatic and emotionally charged operations in the history of MAC was OPERATION HOMECOMING—the return of prisoners of war from Hanoi, North Vietnam. A well-coordinated DOD program, HOMECOMING began in February 1973 when the first increment of 600 Americans and third-country POWs captured in Indochina were airlifted to freedom.

MAC's combined force of aeromedically configured C-141s and C-9s completed 118 missions in two phases. Phase I was performed by C-141s which airlifted 567 POWs from the release point at Gia Lam Airport at Hanoi to the Joint Central Processing Center at Clark Air Base. Navigation into Gia Lam required the utmost use of the skills of each navigator. There were no approach aids and ceilings were generally very low. Yet each professional navigator was able to direct his aircraft safely to its destination.

Each of the 17 flights moved no more than 40 returnees, each with a seat and a litter available to him. Phase II of HOMECOMING was the airlift of the POWs from Clark Air Base to one of five dispatch points in the CONUS—Travis, Kelly, Scott, Maxwell, and Andrews AFBs. Phase II required 38 C-141 missions. Once in the CONUS, 61 C-9 missions were flown from these points to 23 airfields throughout the CONUS near designated hospitals and medical centers. The last returnee was delivered at McGuire AFB early in April. C-141 aircraft logged 1,543 flying hours, and the C-9s flew 270 hours. Both aircraft operated at 100 percent reliability.

ISRAELI AIRLIFT

In its 28-year history, MAC and its predecessor, the Military Air Transport Service, have performed some dramatic airlifts. The first—the Berlin Airlift, performed a month after MATS was created—saved a city; 25 years later, another—the Israeli Airlift—saved a country. It was October 1973 when Syria and Egypt attacked Israel. Sustained by a Soviet air and sea lift of war materials, the Arab nations threatened to overrun Israel who appealed to the United States for resupply of its depleted war supplies.

Within hours after the United States' decision to resupply Israel, MAC had launched what was to be a steady stream of C-141s and C-5s loaded and airborne on their way to Israel. A large portion of the cargo airlifted to Israel was unique in that it could not be carried in any other aircraft in the free world except the C-5. Items which otherwise would have had to be sent by ship included the M-60 and M-48 battle tanks, each weighing approximately 100,000 pounds; 175mm cannons at 56,000 pounds each; 155mm self-propelled howitzers at 49,000 pounds each; CH-53 helicopters; and fuselages for F-4E aircraft.

As in the Berlin Airlift, where the transports had to travel in a narrow corridor from West Germany into Berlin, the MAC C-141s and C-5s flying into Tel Aviv had to carefully navigate their way through the Mediterranean from Lajes and return to avoid overflying any foreign territorial space. The statistics at the end of the 32-day airlift were impressive; 567 missions flying 18,413 hours delivered 22,318 tons to Israel.

AEROMEDICAL EVACUATION SYSTEM

The USAF aeromedical evacuation system, an integral part of MAC's combat airlift role, is divided into three subsystems: domestic, Pacific, and European. This combination of overseas and domestic aeromedical evacuation systems is today capable of delivering a patient from anywhere in the world to a specialized stateside medical facility within 36 hours.

Worldwide aeromedical evacuation command and control is accomplished through a network of aeromedical evacuation command posts and subordinate control centers. The domestic system, operated by the 375th Aeromedical Airlift Wing, located at Scott AFB, Illinois, is responsible for movement of patients within the CONUS and to/from certain offshore areas. For this mission the C-9, a commercial DC-9 modified specifically to accomodate patients, has proven its mettle as the primary evacuation aircraft. Both the C-141 and C-9 are used on overseas aeromedical evacuation missions. There are four C-9s located at Clark Air Base, Philippines, and four at Rhein-Main Air Base, Germany.

Timely shipments of self-propelled 175 mm field artillery cannon, shown offloading from a C-5 at Lod Airport, helped Israelis recover from initial losses.

HUMANITARIAN AIRLIFTS

A wide range of humanitarian airlifts performed by MAC aircraft and crews have included not only scheduled operations, but also emergency missions to aid in disasters. Oftentimes regularly scheduled MAC flights have been diverted to provide assistance to someone in need.

In 1964, for example, following the Alaskan earthquake, MAC joined other U.S. agencies in airlifting medical supplies, water purifiers, and communications equipment to the Anchorage and Kodiak areas. In 1965, five seriously burned survivors of the sinking Yarmouth Castle were evacuated and given medical aid by a MAC medical crew aboard an ANG C-97 flying aeromedical missions for MAC. In the winter of 1967, when over 50,000 Navajo Indians were stranded in the mountains of northwest Arizona, MAC ARRS units airlifted over 349,000 pounds of food, medical supplies, and heavy snow-moving equipment to the area. Other humanitarian missions were the relief assistance to Peruvian earthquake victims in June 1970 and the airlift in the summer of 1969 of VA hospital patients from Gulfport, Mississippi, after it was hit by Hurricane Camile. MAC was also there in late 1972 to aid Managua, Nicaragua, after its disastrous earthquake.

Volunteers carrying orphans aboard C-141 at Hickam AFB.

OPERATION BABYLIFT

On 3 April 1975 President Ford, in the face of an imminent takeover of South Vietnam by the Communists, announced a plan to evacuate 2,000 Vietnamese orphans. He further directed that "C-5 aircraft and other aircraft, especially equipped to care for these orphans during the flight, be sent to Saigon. I expect these flights to begin within the next 36 to 48 hours."

Within hours the dramatic airlift, named OPERATION BABYLIFT, was under way; enroute facilities were readied, and a C-5 and a C-141 were headed for Saigon. Although the operation began on 4 April with the tragic crash of the C-5 near Tan Son Nhut Air Base with 247 Vietnamese orphans aboard, the flow of MAC aircraft to and from the airfield near Saigon continued as scheduled.

With the near collapse of the Cambodian government, the initial phase of BABYLIFT was expanded to include the evacuation of Cambodian orphans. Using Bird Air C-130s and a commerical aircraft chartered by World Vision Relief Organization, 52 orphans were flown to U-Tapao, Thailand. A MAC C-141 later moved them on to Clark Air Base. The Vietnamese orphans were flown to Clark and to Hickam where organized teams and volunteers examined, cleaned, entertained, and prepared the orphans for movement on to the CONUS processing centers on the west coast. Those not medically capable of making the entire trip were hospitalized at Clark, Guam or Hickam, then later moved to the United States via the MAC aeromedical evacuation system.

Although statistics vary, it appears that a total of 1,794 orphans were transported to the United States. MAC aircraft evacuated 949 in 24 flights and the remaining 845 were flown by commercial contract carriers. The operation was officially terminated by the State Department on 9 May 1975.

C-141/C-5/C-130 FORCE

The C-141 Starlifter, the backbone of MAC's airlift force, has proven to be the medium-sized, fast workhorse that MAC needs, enhancing the flexibility of MAC's airlift operations.

Teamed with the C-141, the C-5 provides airlift capability for the very large and bulky items of equipment organic to heavy combat divisions. MAC received its first C-5 aircraft on 17 December 1969, which, as a matter of interest, was the anniversary of the Wright brothers' first flight 66 years earlier. The cargo floor of the C-5 is one foot longer than that historical first flight.

The addition of the C-130 rounds out MAC's airlift fleet with a highly versatile workhorse. This aircraft's ability to operate world-wide in an austere environment with superior efficiency adds greatly to MAC's flexibility.

AIRLIFT CONSOLIDATION

In July 1974 the Secretary of Defense directed the consolidation of DOD airlift. The resulting actions transferred all CONUS tactical airlift resources from the Tactical Air Command to MAC in December 1974 and all overseas tactical/aeromedical airlift in March of 1975. From within the CONUS, MAC gained two air divisions, four tactical airlift wings, one aerial port

squadron, an aeromedical evacuation group, plus related personnel from HQ TAC and the numbered Air Forces. From the Pacific, MAC gained an aeromedical evacuation group, an aeromedical airlift squadron, an aerial port squadron, and a tactical airlift wing. From Alaska came a tactical airlift squadron, a composite wing, and airlift personnel. Southern Command provided airlift personnel who were assigned to a rotational airlift squadron. In addition to these resources, MAC gained nine AFRES tactical airlift wings, three ANG tactical airlift wings, and 38 ANG/AFRES Prime Beef Teams.

Subsequent actions saw the inactivation of one of the CONUS tactical airlift wings, an aerial port squadron, and a European airlift wing. The net result of consolidating airlift under MAC was better cross-utilization of strategic and tactical airlift assets and the elimination of duplicate logistic and support facilities, aerial port facilities and redundant route structures. The manpower savings within the first year included 90 headquarters management spaces and 383 spaces through unit inactivations. Related unit inactivations have eliminated an additional 1,012 spaces.

TECHNICAL SERVICES

The services assigned to MAC have provided specialized support to many DOD elements for many years. In fact, some of the service predates the airlift function. Air Weather Service (AWS), for instance, dates from 1937. The largest of the MAC services, it provides meteorological support to all elements of the Air Force and the Army through its network of observation and forecasting stations. Still other missions of AWS include support to space shots, weather modification (cold fog dissipation), and climatology.

In 1961, in accordance with the single manager concept, the Airways and Air Communications Service of MATS was redesignated the Air Force Communications Service, a new major air command, with the mission of providing communications for all the components of the Air Force.

Also, in 1961, Air Rescue Service became responsible for the Inland Search and Rescue Program. The command also became increasingly involved in the recovery of space hardware and in the recovery of astronauts and their equipment, a mission that in 1966 led to a name change—Aerospace Rescue and Recovery Service (ARRS). ARRS played an important role in the Apollo space program by providing emergency recovery capability with aircraft and crews positioned around the world. On 1 January 1964, ARRS was assigned responsibility for recovery of aerial sampling balloons and their payloads launched by Air Weather Service. In addition, ARRS aircraft and crews were called upon to perform mercy missions following natural disasters such as floods, earthquakes, hurricanes, etc. Also, ARRS was there for rescue operations in Southeast Asia, saving many aircrew members from death or capture by the enemy. In 1975, ARRS assumed airborne weather reconnaisance and atmospheric sampling missions from AWS.

The predecessor of the Aerospace Audio-Visual Service (AAVS), the Air Photographic and Charting Service (APCS), had two main functions: (1) photomapping and geodesy, and (2) photography. APCS operated the Aeronautical Charting and Information Center, St. Louis, until 1958. In March 1962, the command took over the entire USAF commerical motion picture program. Space programs expanded both the photomapping/geodetic and photographic functions. On 15 May 1963, AAVS, for the first time, photographed a Mercury shot at Cape Canaveral (Kennedy) from an aircraft. In March 1965, camera pods mounted on TAC F-4Cs recorded the high altitude phase of a manned space launch. Responsibilities of AAVS expanded further to include maintaining a pictorial account of Air Force combat and support activities around the world, especially Vietnam activities.

Today, General Paul K. Carlton directs the global operations of the Military Airlift Command from its headquarters at Scott AFB, Illinois. The command consists of two air forces—the 21st at McGuire AFB, New Jersey, responsible for airlift operation in the hemisphere east of the Mississippi River (extending to New Delhi, India), and the 22nd at Travis AFB, California, operating in the hemisphere west of the Mississippi River; three technical services—AAVS, ARRS, and AWS; and three specialized wings—the 89th Military Airlift Wing at Andrews AFB, operating special airlift missions for U.S. and foreign dignitaries, including the President of the U.S., the 443rd Military Airlift Wing at Altus AFB, providing advanced aircrew training, and the 375th Aeromedical Airlift Wing at Scott AFB, operating the domestic aeromedical evacuation system.

MAC's global mission, a legacy of hard work and determination from the past, is an integral part of the defense establishment and an instrument of national policy. It is also a mission which presents the American flag in the mercy and humanitarian roles that the world has come to expect. MAC navigators have played a tremendously important part in its mission and shall continue to do so in the future.

the SAC navigator -- our profession

Lt Col Claude E. RIGGS, Jr.
Headquarters Strategic Air Command
Offutt AFB, Nebraska

"The Strategic Air Command will be prepared to conduct long range offensive operations in any part of the world, either independently or in cooperation with land and naval forces...to conduct maximum range reconnaissance...to provide combat units...to train units and personnel in maintenance of the strategic forces in all parts of the world..." Thirty years ago, General Carl Spaatz, the Army Air Force Commander, issued the Strategic Air Command's charter and in so doing he assured that the SAC navigator would always be "where the action is."

It is not necessary to expouna at great length on the past history and present credibility of SAC. The flexibility of a mixed force of manned bombers and missiles in the global concept of operation has certainly been tried, tested, and proven. Recognition of these facts by potential adversaries is evidenced in the nuclear peace we all enjoy. The original charter General Spaatz outlined has weathered three decades in this dynamically changing world and "peace is (still) our profession."

Contributions by navigators in building and maintaining the reputation of the Strategic Air Command are well recognized. Their accomplishments, in many instances, have tipped the scales toward success of aircrew, unit, and command.

As a rated flying officer, the SAC navigator can expect his first years to be devoted primarily to the varied aspects of aircrew duty. It is no small feat perfecting the skills introduced in undergraduate training and developing the new techniques required for specialization.

There are very few aircraft in the SAC inventory that do not require the technical expertise of a navigator. One-half of the six man crew aboard the B-52 are navigator trained. A radar navigator shares the FB-111 cockpit. The RC-135 requires two primary crew navigators and from

EC-135C Airborne Command Post.

B-52 dropping tons of ordnance on enemy positions.

SR-71.

Almost one-half of the navigators in the Air Force are in SAC. It follows, therefore, that SAC is the lead command for navigator enhancement. Officers who have established solid operational backgrounds can broaden their experience base through a tour in one of many support career fields. Selectively manned units such as the First Combat Evaluation Group, numbered air forces, and SAC Headquarters also utilize the talents of proven navigators. Note: The positions described above are not reserved for the "old heads."

one to nine specially trained navigator electronic warfare reconnaissance officers. Mission success of the KC/EC-135 and the DC-130 drone carrier is dependent upon the navigator. A navigator trained reconnaissance systems operator (RSO) performs sophisticated duties in the ultra fast and high flying SR-71. Even the U-2 employs a special navigator team for mission support.

Crew duty is certainly a demanding time, but is also a time that can be personally and professionally rewarding for those who accept the challenge and achieve the standards. Whether in a B-52 at low altitude conducting a simulated weapon delivery; sorting- logging- analyzing electronic signals in a RC-135; at mach three plus, above 80,000 feet in the SR-71; or leading a flight of tactical fighters across the ocean in a KC-135; the difficult and varied duties in the disciplined crew environment provide the foundation for additional growth and is the first proving ground.

Outstanding performers are also recognized early in the Strategic Air Command, and opportunities for advancement as instructors, standardization evaluators, and wing staff officers are plentiful.

FB-111.

KC-135 refueling B-1.

B-52 loaded with SRAMs.

KC-135.

Modern technology has both increased and upgraded the expertise and knowledge required of the airborne operator. You can expect to move faster in today's SAC. Young and aggressive people are very much in demand. The premium is on performance and potential.

In the previous paragraphs, I've described some of the routes a SAC navigator can plan for and follow toward career advancement. Being prepared when the door opens is an individual responsibility. Basic to this preparation is mastering the flying skills and acquiring the military and academic educational base required for increased growth. Another door is now open to the navigator.

On 18 December 1974, President Ford signed Public Law 93525. With a stroke of his pen, he opened a door and exposed a path never before legally accessible to navigators. Title 10, US Code, Chapter 845, Section 8577 had limited entirely the top growth jobs in flying organizations for the Air Force navigator. Lifting this legal restriction to command flying units accomplished two significant things. First, it certainly enhanced the image of the Air Force in the eyes of navigators. Second, it established a much larger pool of potential commanders from which the Air Force could choose.

Predictably, SAC has been the front runner in assigning navigators to positions of command and the stepping-stone jobs preparatory to command. One general officer now serves as an Air Division Commander. Navigators are presently assigned as Tactical Squadron Commanders and Operations Officers. One-third of this command's training division offices are now headed by navigators. Competition for selection to the "top" is keener and the standards are also higher. This is as it should be and must be if SAC is to live up to the motto "Peace is our Profession." Obviously, the opportunities are available for the navigators who are prepared.

Lt Col Claude E. RIGGS, Jr.

Lt Col Claude E. Riggs, Jr., entered the Air Force in 1956 through ROTC after graduating from Memphis State University. An 18-year veteran of SAC, he has accrued 10 years of crew duty as a navigator and a radar navigator, including 1500 combat hours in SEA. Lt Col Riggs spent over seven years in Stan/Eval while doubling as an instructor. Following three years in SAC Bomb Nav, he now serves as the Chief of Ground Training, Directorate of Training, DCS/Ops, at SAC Headquarters, Offutt AFB.

The Air Force Reserve Navigator in the "TOTAL FORCE"

Mr. Gerald CANTWELL
Headquarters Air Force Reserve
Robins AFB, Georgia

The term "Total Force," as Defense Department concept or policy is officially only four years old, but Air Force Reserve navigators have been contributing to the total force for over a quarter of a century.

THE KOREAN RECALL

They turned up first in June 1950 when the Korean war broke out. By the time that conflict had run its course in 1953, over 2,000 Air Force Reserve navigators had been mobilized. The recalled reservists' Korean service fell generally into three categories. Some, about 575, remained with the C-46 and B-26 Air Force Reserve units with which they had been mobilized. Another 850 or so, also recalled as part of C-46 and B-26 units, were dispersed as fillers to active duty units, primarily those of the Strategic Air Command. The remaining several hundred had not been affiliated with a reserve unit and were recalled as individuals. They, like the personnel of the disbanded units, were dispersed as filler personnel throughout the Air Force.

Although it is difficult to measure the contribution of the filler navigators, it is possible to trace the contribution of the others by following the careers of their units, one B-26 and nine C-46/C119 wings.

The 452d Bombardment Wing, for example, was not only the sole reserve B-26 unit to remain intact, but also the first Air Force Reserve wing of any description to reach the theater. They were in combat 77 days after recall to active duty. The wing was stationed at Itazuke and Honshu in Japan, and at Pusan East Korea. Two distinct phases marked the wing's career in the theater. First, its operations were confined to daytime close support interdiction missions. In June 1951, however, it converted to night operations and concentrated on night attacks. During its period of combat in Korea, the 452d flew more than 12,000 combat sorties—9,000 as night missions. The wing and three tactical squadrons it retained earned two USAF Distinguished Unit Citations. The 731st, detached from the Wing even before reaching the theater, served exclusively in night operations. Before returning to inactive status, the squadron flew over 2,000 combat sorties and earned the Distinguished Unit Citation.

Two Air Force Reserve troop carrier units also served in Korea. The C-46 equipped 437th mobilized on the same day as the B-26 wing and reached the theater almost concurrently. Later, the 403d Troop Carrier Wing converted to C-119s and went over in April 1952.

Of the other seven troop carrier wings mobilized and kept intact, one of the first two recalled in October 1950 immediately converted to C-119 operations and deployed to Europe and NATO. The other converted to C-82s and supported the U.S. Army Infantry Schools' airborne training requirements. The first five mobilized early in 1951, completed the Tactical Air Command's (TAC) new Eighteenth Air Force.

Curtiss C-46 Commando.

RESERVE NAVIGATION TRAINING PROGRAM

After its Korean experience, the Air Force sought to preclude recurrence of the severe navigator refresher training problem it had encountered during the conflict. While the 1,400 or so reserve navigators who had accompanied their units to war had been qualified and current in their unit equipment, the several hundred nonaffiliated navigators who had been individually recalled were not. Most had not flown for three to five years and had been put through accelerated refresher training programs. Demobilized, they returned to civilian life and the Air Force had had to write off another investment.

Following a long series of exploratory correspondence, in June 1954, representatives of the Air Staff, Military Air Transport Service (MATS) and Continental Air Command (CONAC), designed a program to prevent a recurrence of the wasteful sequence. CONAC organized a reserve navigator training program projected to produce and retain 3,400 qualified reserve navigators by the end of 1958.

The CONAC program was an immediate success and for the next 13 years, until its demise in July 1967, it kept qualified all the reserve navigators to fulfill the requirements of MATS' war plans. Economy measures coupled with new modern equipment requiring fewer aircrews reduced MATS' requirements, thus, the CONAC program was cancelled.

The MATS M-Day requirement for reserve navigators consisted of two parts: the command's own military requirement and the Civilian Reserve Air Fleet (CRAF) requirement. CRAF was an emergency augmentation force of aircraft and crews which the civil airlines would furnish MATS on M-Day. However, since the civil carriers did not use navigators on domestic routes, MATS would have had a serious M-Day navigator shortage if it were not for the reserve resource. Originally, the CRAF navigator requirement was to have been met by levies upon MATS and Air Training Command (ATC) instructor personnel, with reservists then filling the vacated MATS and ATC positions. However, in January 1959, MATS won Air Force approval of a proposal for the reservists to fill the CRAF requirement directly. By this time, the airlift command was extremely confident of its reserve navigators. They were all MATS qualified, completely equipped with necessary personal gear. Most lived near the east and west coast CRAF mobilization points. In 1958, 800 of them had flown the line with MATS during their annual 51-Day active duty tours with, as MATS reported "excellent operational achievements."

B-26 Invader.

At this point, MATS was dealing with an extremely mature, experienced, and motivated reserve force. Collectively, the reserve navigation training squadrons' 96 per cent manning rate was the highest among reserve programs. Many were getting to be old-timers. One squadron's members for example, counted slightly over 37,000 flying hours, including over 1,200 in combat. Seventeen of its members had served during World War II or Korea and had earned 41 Medals and seven Distinguished Flying Crosses. Another squadron presented 23 of its members Air Force Reserve 10 year medals, in a mass ceremony on one of its training weekends.

C-82 Packet.

Gradually, however, the MATS projected wartime need for navigators lessened and the reserve navigator training program experienced a parallel drop. By the start of 1963, the requirement was down to 787, and in September only the CRAF requirement of 325 remained. This requirement was dropped to 253 in early 1961. By January 1967, even the CRAF requirement was down to 150, and recognizing that it was no longer economical for CONAC to operate a program dedicated to satisfying the reduced need, Headquarters Air Force made Military Airlift Command (MAC), as the former MATS was known, responsible to train reserve navigators for CRAF.

THE AIR FORCE RESERVE UNITS

Meanwhile, as the fortunes of the individual reserve navigator training program rose and fell, another block of reserve navigators, in later years joined by those attriting from the individual program trained and served the Air Force in the Air Force Reserve Category A units. These consisted variously of 38 to 45 squadrons flying at different times C-46s, C-119s, C-123s, C-130s, C-7s, and in the MAC associate program, C-141s and C-5s.

To be gained by either MAC or TAC upon mobilization, these airlift units contributed over the years, on both inactive and active duty, to the accomplishment of the Air Force mission. As integral members of each aircrew, the navigators played their part.

THE INACTIVE DUTY CONTRIBUTION

The Air Force Reserve units' first post-Korean chance to prove themselves on inactive duty came in the summer of 1956. In Operation 16-Ton they airlifted over 850,000 pounds of LORAN equipment from Floyd Bennett NAS to the Carribbean for the U.S. Coast Guard. In this first "by-product" return from the Air Force's investment in reserve training, the reserve C-46s and C-119s flew about 3,000 accident-free hours in 164 missions.

Operation 16-Ton was just a beginning, a precedent, and ever since then reserve navigators have flown with aircrews that performed live missions for the Air Force, DOD, and NASA.

In February 1965, the navigators, two at a time, were there when reserve C-124 units began flying into Saigon, inaugurating an 11 year Air Force Reserve involvement in the SEA conflict. These were volunteer crews flying on inactive duty; nevertheless, like others who flew into Saigon, they attracted mortar and sniper fire. Before the C-124s passed from the Air Force Reserve inventory in 1973, the reservists had flown 1,294 missions into Saigon, expending 106,800 accident free aircraft hours. In addition, other reserve navigators were part of the 178 crews who ferried 131 C-130s and 47 C-119s to and from Southeast Asia. Finally, there was the great contribution of the reserve navigators in the associate units which flew all the MAC routes, including the Southeast Asian runs.

In the meantime, reservists had responded when the Dominican Republic crisis broke out two months after the C-124s began flying into Saigon. Volunteer reservists on inactive duty flew 1,844 missions, and 16,859 accident free hours including 180 missions into the island during that crisis. Because of the C-124 commitment to Asia, most of these missions were flown by the C-119 units. Their capability and reliability having been demonstrated, MAC and TAC continued to use them on off-shore missions for the duration of the C-119s' stay in the Air Force Reserve inventory. This allowed the larger four-engine aircraft to be free for the longer overseas hauls.

C-119 Flying Boxcar.

C-123 Provider.

In the Fall of 1973, the reserve associate crews, including the navigators, made a great contribution as the United States responded to Israel's cry for help during the Mideast War. Six hundred and fifty reserve aircrewmen, including a proportionate share of navigators, volunteered to crew the C-141s and C-5s, airlifting strategic cargo. Ultimately, 286 reservists were used on Mideast runs, including 183 who flew into Israel. Among the latter were twenty-four all reserve crews. In the meantime, 1,495 reservists flew normal MAC line missions, taking up the slack created by the emergency response.

C-124 Globemaster.

It was during this same period that the "Russian Odyssey" took place. On 23 October, First Lieutenant Jimmy Jackson was the reserve navigator aboard an associate C-141 that was diverted from Rhein-Main AB to Moscow. There a Russian navigator came aboard and the flight continued to Irkutsk to pick up an American citizen badly in need of a whole blood transfusion. The patient, who had been in Russia with a cultural exchange group, was safely evacuated.

C-130 Hercules.

C-7 Caribou.

THE ACTIVE DUTY CONTRIBUTION

The Air Force Reserve was conceived as a mobilization force, and it has been used for that purpose four times since Korea. In October 1961, 44 navigators came onto active duty with five C-124 squadrons. Operating out of their home stations, these units flew 12,030,124 passenger miles and 18,326,679 ton miles for TAC before being released from active duty in August 1962.

Two months after their return, the call went out again, this time for eight C-119 wings on the occasion of the Cuban missile crisis of October 1962. Three hundred and eighty navigators accompanied their units into active duty. Although the units were released a month later, 64 navigators were among the 442 reserve crewmen who voluntarily remained on active duty for 15 days to help return dispersed Air Force units to their precrisis stations.

Twice in 1968, Air Force Reserve units were mobilized for Southeast Asia support. In January, the recalled units included five C-124 groups which took 177 navigators with them. Before being released from active duty in May 1969, these reserve units flew 2,406 missions, including 927 in Europe and 452 into Southeast Asia. Their presence in Europe in the form of a rotational squadron freed a C-130 wing for reassignment to Southeast Asia.

In May, a single C-119 group was mobilized and its tactical squadron converted to AC-119 gunship operations. The squadron then deployed to Nha Trang AB where it flew over 1,450 armed combat missions as an element of the 14th Special Operations Wing. Sixteen reserve navigators accompanied the squadron into combat.

THE RESERVE NAVIGATORS STILL READY

There are approximately 660 combat ready reserve navigators presently assigned to the Air Force Reserve's airlift, special operations, and associate squadrons. The record suggests that, like their units, they are ready to continue their Total Force contribution to the Air Force mission, in peacetime, and on active or inactive duty.

SATELLITE NAVIGATION: MULTIPLYING THE NORTH STAR

Rockwell International
Pittsburgh, Pennsylvania

Editor's Note; The following article is a reprint from the SKYLINE magazine, published by Rockwell International, Vol 33, Number 1, 1975. You have looked at the navigator's past but what about his future. The satellite navigation system, if adopted, would continue the rapid development of the navigational state-of-the-art.

Thousands of years ago, primitive, nomadic man wandered the Earth in search of shelter, food and safety.

With little to guide him except instinct and memory, he was in constant danger. But, even then, before recorded history, man looked to the skies to find the constant North Star. He soon learned that the position of heavenly bodies could guide earthbound exploration.

As man ventured farther and farther into the unknown, he refined his knowledge and found instruments which could guide him on his journeys. Before the birth of Christ, man used the quadrant and astrolabe to determine his earthly position by sighting the stars, while the magnetic compass provided direction.

Then, as man moved into the age of exploration in the fifteenth century, he added the dimension of time with the sandglass.

The centuries-long evolution of navigational devices seems static compared with the progress made during this century with the discovery of the radio. Following Marconi's ship-to-shore communication in 1897, came radio direction finders, radar and finally today's sophisticated black boxes.

But, despite the sophistication of these electronic black boxes and outstanding skills of navigators in aircraft, in ships at sea or in land transport, precise, pinpoint navigational "plots" are the exception rather than the rule; and such navigational information is obtainable only after using a varying amount of equipment and manual preparations which take time.

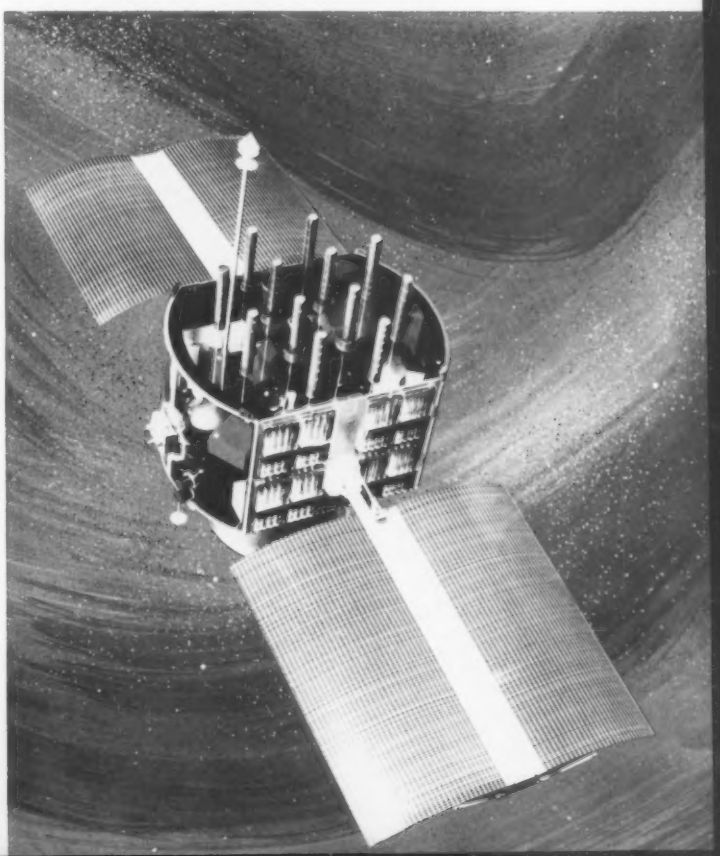
How could we improve the science of navigation? How could we obtain accurate locations and velocities of all types of transport? And, how could we get this precise information almost instantaneously? The answer is from space.

For the past ten years, there has been intensive research on improving navigational equipment and techniques conducted by a number of organizations. Among the leaders has been the Navy with its Timation Program and the Air Force with its system 621B, and these efforts, joined by other military service units along with studies by private researchers and scholars and elements of industry, have produced a wealth of information.

Late last year, the Department of Defense charted a course of action and outlined responsibility for program development of a system which could revolutionize the science of navigation.

It is a joint-service project under the Department of Defense and headed by a program manager from a Joint Program Office located at the U.S. Air Force's Space and Missile Systems Organization (SAMSO), in El Segundo, California. And, it includes deputy program managers from each of the military services, as well as the Defense Mapping Agency.

Photo Courtesy of Rockwell International



The title of the Program-NAVSTAR Global Positioning System (GPS) (NAVSTAR is an acronym for navigation system using time and ranging)-describes the type of system outlined for development.

It is worldwide in scope and will include a series of satellites circling the Earth in varying orbital planes. These satellites will produce continuous signals based on the micro-second timekeeping of a rubidium clock.

The system will include receiver equipment and data processors to translate the signals into accurate longitude, latitude, altitude and velocity readouts.

While the technology of the NAVSTAR Global Positioning System is, for all intents, based on present day state-of-the-art, there are features which require developing, innovating and perfecting. On this basis, the development of the NAVSTAR program will be in an evolutionary three phases.

Program time schedule calls for phase one, validation of the NAVSTAR concept, to be concluded in 1978. The second phase will be completed in 1981-82, and in the third phase which ends in 1984, NAVSTAR will be fully operational.

In the validation first phase, which got underway in mid-June with selection of a satellite or spacecraft hardware contractor, there will be six satellites operating in two circular orbital planes some 10,000 miles above the Earth. The second phase calls for an additional five satellites orbiting in three 10,000-mile planes.

In the fully operational phase there will be a total of 24 satellites orbiting in three 10,000-mile orbital planes sending out continuous signals enabling aircraft, ships, land vehicles or individuals equipped with the proper receiver to determine, almost instantaneously, their exact position at any time and in any weather.

Rockwell International's Space Division was selected by the SAMSO Joint Program Office to design, develop, and test the phase one satellites for the system. Under an incremental contract with a total value of $42.8 million, the Space Division will build five flight satellites and a qualification spacecraft which later will be refurbished as a backup flight vehicle. The sixth satellite in the phase one system will be a Navigational Technology Satellite (NTS-2) built by the U.S. Naval Research Laboratory as part of the joint program. The Space Division will supply two navigation payloads for inclusion on the NTS-2, to be launched in late 1976.

In 1977, the five Rockwell satellites will be launched atop Atlas-F boosters to the 10,000-mile circular orbit. The satellite signals during phase one will provide a four to six hour daily test period over the southwestern United States, and should enable SAMSO's Joint Program Office to run tests on the value of the system.

U.S. Air Force Colonel Bradford W. Parkinson, who is responsible for SAMSO space navigation systems, has been named NAVSTAR GPS program manager. Col. Parkinson, a graduate of the U.S. Naval Academy, has a Masters degree in Astronautical Engineering from the Massachusetts Institute of Technology and a PhD in Astronautical Engineering from Stanford.

For Rockwell International's Space Division, Vice President Richard Schwartz has been named as program manager. Schwartz had been vice president for the division's Space Systems & Applications organization prior to his new appointment.

Col Parkinson, in a background briefing on the NAVSTAR GPS program, pointed out that "While this is a joint military project, we envision 30,000 daily military users of the system."

The program management philosophy, Col Parkinson explained, "Is not only to meet our fully operational and navigation technology objectives with the highest quality equipment, but to exercise controls ensuring that our system, over a ten-or-more-year period of time, will be available to all potential users at a nominal equipment cost."

Col Parkinson continued, "Phase one is for concept and design validation but we're also going to pin down our costs, and the only way I know to really do this is to build the hardware."

Rockwell's Dick Schwartz added emphasis to Colonel Parkinson's words by pointing out that with NAVSTAR "We are setting out to prove the largest operational satellite program ever undertaken. With the launching of the phase one satellites we will be able to determine not only the operational capabilities of the program, but also that we can achieve the desired navigational accuracy at the projected low cost".

With the NAVSTAR GPS time schedule, it is feasible that the phase three navigational satellites could be launched aboard NASA's Space Shuttle. "We're designing the satellites for a four-year-plus life expectancy.

"There is no doubt that if for some reason satellites in the operational phase don't go up by shuttle, replacement satellites will be carried on shuttle flights," explains Schwartz.

Air Force Secretary John L. McLucas recently called for advancement of NAVSTAR GPS because, "We need a system which can accurately and almost instantaneously provide data on position, course and speed any place in the world for a number of different users with the simplest possible user equipment."

The Army, for example, is interested in NAVSTAR GPS because of the benefits it can provide to the individual infantryman. With the development of a lightweight, backpack receiver, the soldier on patrol would know his exact position regardless of terrain, weather or lighting.

One of the main benefits to all branches of the military service is that the receiver is passive—it does not give off any energy or signal and cannot be detected by an enemy.

The SAMSO Joint Program Office recently contracted for the user equipment. This contract calls for building of compact user sets of equipment consisting of receiver, processors and display sections. The equipment will receive radio signals from the satellites, determine the three-dimensional position of the set — in addition to time and velocity determinations—and display the information in an easily readable fashion.

"The applications of this system," says Col. Parkinson, "are limited only by our imaginations. Who can project the benefits of a system where anyone, at any time, can determine his exact location by just pushing a button?"

Course Training Standard Conference - 1975

Did you ever wonder how navigator training programs were developed so that all using commands would be satisfied as to the tasks learned and the level of proficiency of each graduate? Between 11 and 13 November 1975, a Course Training Standard (CTS) conference was held at Mather AFB to accomplish just that. Examining both the Undergraduate Navigator Training (UNT) and Navigator Bombardier Training (NBT) programs, the conference afforded attendees an opportunity to express views on which capabilities and what level of proficiency each graduate should possess. Representatives from TAC, SAC, MAC, ATC, and HQ USAF, joined to discuss broadening requirements and changing trends. The Navy and Coast Guard also attended the conference, as current plans call for Mather to conduct aerial navigation classes for the two services beginning in July of this year.

Col Leo D. O'Halloran, Jr., 323 FTW/DO (Left), Col Francis R. Fanning, HQ USAF/DPPTF (Center), Col George W. Engel, Jr., ATC/DON (Right), discuss the conference and its impact on navigator training.

Conference attendees from the Navy and Coast Guard were, from Left to Right: LCDR Lundquist (USN), LCDR Johnson (USN), and LCDR Heatherman (USCG).

Conference members very thoroughly discussed each part of the CTS. The CTS listed the tasks required of graduates, and specified the levels of proficiency necessary to function properly in various operational environments. The standard was developed as the basis for more detailed course control documents and training evaluation instruments for the courses.

Both the UNT and NBT conferences were exceptionally productive, as the various commands were able to utilize the discussions as the first step in refining the programs to fit the needs of all the attendees. The commands further expressed great expectations for the next CTS conference.

IMPROVING YOUR CELESTIAL ACCURACY

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There we were "slipping the surly bonds" in a B-52 at 33,000 feet on a celestial navigation leg. Not just any flight, but a standboard evaluation check for the navigator. The Electronic Warfare Officer (EW), who doubles as the celestial observer, had just begun the last shot of the sun for the final MPP, when out of the blue came, "Reno 20, descend to flight level 310." No, not on a checkride! The pilot argued, but to no avail, so he started a slow descent and managed to lose only 10 knots of airspeed. The first two LOPs were 15 away and 14 away. The third LOP was 15 away. How did we do it—by the application of acceleration correction, of course.

Believe it or not, that is a true story. If you're the type of navigator who is satisfied with 15 to 20nm circular errors (CE) on nav legs, don't read any further. If, on the other hand, you take pride in your work and like a challenge, what I have to say is for you.

It goes without saying, that many things affect the results of your nav leg, but I'm assuming that everyone knows how to compute GHA, Dec., LHA, and motions, and plots with precision. The purpose of this article is to discuss two more methods that will cut that CE down to less than embarrassing size.

Acceleration and wander errors are two variables of celestial navigation for which there are accurate, uncomplicated methods of adjustment. By taking note of your available flight instruments, doppler groundspeed, and any heading system, at the start and end of each two minute observation, you can precisely determine the magnitude and direction of any errors induced by a sloppy autopilot or unscheduled deviations of speed.

The first correction I will discuss is for acceleration errors. The table illustrated in Figure 1 is the one I prefer. The first item to note is that the chart is based on two minute observations, not one minute or any other increment of time. Second, there are Zn minus track values to compute, as with motions. This can be computed as Zn minus track or Track minus Zn. I always use Track minus Zn because I prefer to use sextant relative bearing during observation. If the Track is less than Zn, add 360° to Track. (Apply drift to the sextant relative bearing to facilitate star identification.)

At the top of the figure you will notice that for "Zn minus Track" values 271-000 and 001-090, if the groundspeed increases, the sign of the correction is positive; if the groundspeed decreases, the sign is negative. For "Zn minus Track" values of 091-180 and 181-270, an increase in groundspeed is a negative correction, and a decrease is a positive correction. The acceleration correction factors are the amount that the LOP must be adjusted for each knot that the groundspeed changes. One vital point to remember is that the correction is applied to the Hc; if you wish to apply it to the Ho, merely reverse the sign.

EXAMPLE #1

Track = 100° Hc = 33° - 00′
Zn = 150° Ho = 32° - 45′

GS at start of shot = 450 GS at end of shot = 440

ACCELERATION CORRECTIONS FOR TWO MIN. OBSERVATIONS

Zn-Track	Increase GS	Decrease GS	
271-000	+	-	SIGN OF CORRECTION TO Hc
001-090	+	-	
091-180	-	+	
181-270	-	+	

Zn-Track		Corr/Kt	Zn-Track	
000	360	1.50	180	180
005	355	1.47	185	175
010	350	1.44	190	170
015	345	1.43	195	165
020	340	1.40	200	160
025	335	1.38	205	155
030	330	1.35	210	150
035	325	1.25	215	145
040	320	1.18	220	140
045	315	1.08	225	135
050	310	1.00	230	130
055	305	.90	235	125
060	300	.80	240	120
065	295	.65	245	115
070	290	.53	250	110
075	285	.40	255	105
080	280	.25	260	100
085	275	.15	265	095
090	270	.00	270	090

Figure 1

With a "Zn minus Track" value of 050°, (or a Track minus Zn of 310°) a decrease in groundspeed means a negative correction. By multiplying the acceleration correction factor (1.00) by the number of knots of groundspeed change (10 knots) and applying the correct sign (negative), the result is a total correction to Hc of (- 10). We now have an adjusted Hc of (32°-50), and the resultant intercept is (5 away).

The second method to reduce your CE is wander correction. Wander correction compensates for errors caused by the wandering of the aircraft heading during the observation of the celestial body. Some of the charts that I have seen are unnecessarily complicated, but Figure 2 is an easy to use, "no-nonsense" type of wander correction chart. You have already computed the Zn minus Track for the motion of the observer, so enter the chart with that figure and your groundspeed to determine a correction factor which is good for each degree of heading change during a two-minute observation.

Multiply the wander correction factor by the number of degrees of heading change and apply it to the Hc. There is one more rule to follow: if the turn is away from the body, the sign is negative; if the turn is toward the body, the sign is positive. (This "sign" can be determined easily by plotting the Zn of the body and aircraft heading on a circular chart.)

EXAMPLE # 2

Zn = 270°	GS = 450K
Track at start of shot = 150°	Hc = 33°-00
Track at end of shot = 151°	Ho = 32°-45

Zn-Tr = 120°
Correction Factor = 10.1
Hdg change = 1°
Sign of correction is plus (the turn is toward the body)
Correction factor (10.1) × number of degrees turned (1°) × sign of correction (+) = +10.1 or +10.
Adjusted Hc = 33°-10
Intercept = 25 away

It is important that you be aware of several considerations before you apply these corrections with reckless abandon. These tables assume that the acceleration and wander of the aircraft are of a constant nature; therefore, if you are shooting celestial and your pilot yanks the airplane into a 45° bank to avoid a mid-air collision, then dutifully resumes a heading which is two degrees in error, you would be well advised to restart your observation instead of trying to apply wander correction. Proceeding on the assumption that these errors are fairly constant, you need only note the groundspeed and heading at the beginning and end of each two minute observation, then compare the numbers and make the appropriate adjustments. In the event that your doppler is not working, an acceptable back-up method is to monitor the true airspeed.

By removing these two unknowns from the navigation formula and judiciously following good fundamentals, you can coast into that ADIZ or nav destination point with increased confidence and improved results. I know this sounds a little confusing, but apply these suggested techniques, and you will be pleased with the increased accuracy obtained.

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WANDER CORRECTIONS FOR TWO MIN. OBSERVATIONS

SRB		400K	450K	500K	SRB	
180	000	.0	.0	.0	000	180
185	355	.8	1.0	1.2	005	175
190	350	1.9	2.0	2.2	010	170
195	345	2.7	3.0	3.2	015	165
200	340	3.5	4.0	4.3	020	160
205	335	4.3	4.9	5.5	025	155
210	330	5.1	5.9	6.5	030	150
215	325	6.0	6.8	7.3	035	145
220	320	6.8	7.4	8.1	040	140
225	315	7.3	8.2	8.9	045	135
230	310	8.0	9.0	10.0	050	130
235	305	8.5	9.5	10.8	055	125
240	300	9.0	10.1	11.1	060	120
245	295	9.5	10.6	11.9	065	115
250	290	9.8	11.1	12.1	070	110
255	285	10.0	11.3	12.3	075	105
260	280	10.1	11.5	12.5	080	100
265	275	10.3	11.8	12.7	085	095
270	270	10.5	12.0	13.0	090	090
left turn pos. corr					right turn pos. corr	

SIGN IS + IF THE TURN IS TOWARD THE BODY; SIGN IS - IF THE TURN IS AWAY FROM THE BODY.

Correction is for 1° hdg change/2 min obsv.

Figure 2

Captain Wayne R. MATHIS

Captain Wayne R. Mathis graduated from Valdosta State College and received his commission through OTS in 1966. After completing UNT and NBT, he was assigned to B-52s at Robins AFB. A Stan/Eval navigator and radar navigator, Captain Mathis has logged 105 SEA combat missions, and his crew placed second in the 1971 Fairchild Trophy bombing competition. He is a Distinguished Graduate of SOS. Captain Mathis is currently attending school at AFIT.

Captain Howard W. BRICKMAN

Captain Howard Brickman is a 1971 graduate of Indiana State University. After receiving his commission through OTS, he went on to complete UNT and NBT the following year. Assigned to B-52s at Utapao AB, Captain Brickman earned an Achievement Award from the 307th Strategic Bomb Wing. He is currently stationed with the 19th Bomb Wing at Robins AFB as the Wing EWO SRAM Officer in Operations Plans. His decorations include the Air Force Commendation Medal.

Silver Wings

I've won the right to wear these Silver Wings
And see the many awesome sights
of which the Poet sings
I've earned a place among the Gods of flight
Under the sun's and moon's eternal light.

I now can join that group so proud
Who can look down upon a cloud
And find their way across unmarked space
Where for them alone there is a place.

I can now join that honored fraternity
Whose members look into eternity
Who fly beyond the fetters of the earth
And see at once, yesterday's death
and tomorrow's birth.

I stand today upon duty's threshold here
Where opportunity is shining clear
And know that what tomorrow brings
Depends on how I guide these Silver Wings.

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